REMARKS

Claims 1-2, 6-9, 12-16 and 18-25 remain within the present application. Claims 1 and 9 are amended herein. Claims 5, 11, and 17 are canceled without prejudice. Applicants respectfully request examination and allowance of Claims 1-2, 6-9, 12-16, 18-25 in view of the above amendments and the arguments set forth below.

Claim objections

Paragraph 3 of the above referenced Office Action states that Claim 17 is objected to as being an improper dependent claim. Applicants have herein canceled Claim 17.

Claim rejections 35 U.S.C. § 103(b)

In paragraphs 4-10 of the present Office Action, Claims 1-2, 6-9, 12-16, 18-25 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Jia et al., U.S. Patent No. 5,726,896 (hereinafter Jia) in view of Gharachorloo et al., U.S. Patent No. 5,488,684 (hereinafter Gharachorloo) and in further view of Luken, Jr. U.S. Patent No. 5,278,948 (hereinafter Luken) and Schulmeiss, U.S. Patent No. 5,717,847 (hereinafter Schulmeiss). Applicants have herein amended independent Claims 1 and 9 to more particularly point out aspects of the present invention. Accordingly, Applicants respectfully submit that due to the above amendments and the arguments set forth below, the present invention is not rendered unpatentable within the meaning of 35 U.S.C. § 103(a) by the Jia, Gharachorloo, Luken, and Schulmeiss references.

Specifically, with respect to independent Claim 1, Claim 1 as amended recites a computer implemented method for rendering a curve or a surface. Specifically, Claim 1 recites in part:

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> ... a computer implemented method for rendering a NURBS defined curve or surface without first converting the NURBS defined curve or surface to a polygon mesh, the method comprising the computer implemented steps of:
>
> a) receiving a NURBS model for rendering from a software program running on the processor of the computer system ;
>
> b) converting the NURBS model to a Bezier model using the graphics rendering pipeline;
>
> c) generating a plurality of Bezier control points from a corresponding plurality of NURBS control points using a tri-linear interpolator in the graphics pipeline by:
>
> c1) using the plurality of NURBS control points as inputs to the tri-linear interpolator; and
>
> c2) evaluating the NURBS control points to obtain each of the plurality of Bezier control points;
>
> d) generating a plurality of points on a curve or surface, wherein the curve or surface is defined by the Bezier model, using the graphics rendering pipeline; and
>
> e) rendering the curve or surface defined by the NURBS model using the plurality of points and using the graphics rendering pipeline such that the curve or surface is rendered without first converting the NURBS model to a polygon mesh. (emphasis added)

Applicants respectfully assert that the embodiment of the present invention recited in Claim 1 is different from the method and apparatus for rendering trimmed parametric surfaces of Gharachorloo and the method and system for spline interpolation and their use in CNC of Jia. Applicants further assert that even with Luken and Schulmeiss, Gharachorloo and Jia do not show the method of the present invention as recited in Claim 1.

Specifically, paragraph 4 of the above referenced Office Action states that Jia et al teach a method of converting a NURBS surface model to a Bezier surface model, evaluating a plurality of NURBS control points into Bezier control points (Col.3: lines 32-37, Col. 4: lines 38-45), and interpolating a plurality of control points (Col. 5: lines 1-5).

In contrast, Applicants respectfully submit that Jia is concerned with the use of spline interpolation for the control of CNC and other numerically controlled machine tools and is completely different from the rendering method recited in Claim 1. Examiner acknowledges this fact by noting that "Jia et al fail to teach the use of tri-linear interpolator, and a method to receive the data from the server (host processor) and rendering it."

Paragraph 4 of the above referenced Office Action further states that Gharachorloo et al teaches "a method to receive data from a host processor into a graphics pipeline, and use the graphics pipeline to render the object (refer Figs. 1, 2, 2A)." Applicants respectfully submit that Gharachorloo specifically recites converting the parametric representation into a polygon mesh prior to rendering (Gharachorloo col 2 lines 25-57). This is exactly opposite the method of the present invention as recited in Claim 1 wherein the NURBS model is rendered directly by the graphics pipeline without first being converted to a polygon mesh. Therefore, Gharachorloo teaches away from the claimed invention.

Paragraph 4 of the above referenced Office Action also states that Luken "inherently teaches the use of tri-linear interpolators by disclosing that the de Casteljau process performs a linear interpolation between the components (x,y,z) of the control points (Col.4: lines 40-54; Col. 15: lines 32-45), the NURBS control points forming the input to these interpolators." Paragraph 4 further states that Schulmeiss "discloses the use of de Casteljau algorithm to calculate Bezier control points (Col. 2: lines 16-22)" and according to the rejection, it would be obvious to one skilled in the art at the time the invention was made to store the surface model data in a host processor, and use this method to download the data as needed. Applicants respectfully traverse.

Applicants respectfully submit that the use of the graphics rendering pipeline to natively render NURBS models is not "inherent" or obvious.

As recited in Claim 1, the present invention functions by using the graphics pipeline hardware to render NURBS curves or surfaces. The hardware of the graphics pipeline (e.g., texture mapping units, etc.) are used to directly render the NURBS curve or surface without intermediate conversion to a polygon mesh as required by Gharachorloo. Prior art references do not natively render NURBS models with the dedicated rendering hardware of the graphics pipeline. For example, in Gharachorloo, the NURBS models are transformed into polygon meshes by software executing on the host processor (e.g., a CPU subsystem 302).

Claim 1, however, explicitly recites utilizing the graphics rendering pipeline to implement a method of natively rendering NURBS models. The hardware of the graphics rendering pipeline (e.g., raster units, texture mapping units, and texture memory, etc.) is designed and optimized for processing conventional graphics primitives and texel data. As recited in Claim 1, the present invention utilizes this existing hardware to natively render NURBS models without first converting them to polygon meshes. The process of the present invention uses tri-linear interpolation to process NURBS or Bezier control points, instead of texels. First, in the case of a Bezier curve, the process of the present invention uses tri-linear interpolator 500 to generate points on the surface defined by the Bezier model. The Bezier control points define a surface. Once the points on the surface are generated, they are fed back as graphics primitives and subsequently rendered into the surface defined by the Bezier model. The process of rendering the points on the curve or surface occurs in the graphics rendering pipeline, without using the CPU subsystem or data transfer bandwidth between main memory and the CPU subsystem or graphics co-processor (as required if the curve or surface is first converted to a polygon mesh). As such, Applicants respectfully submit that the use of the graphics rendering pipeline to natively render NURBS models is not "inherent" or obvious.

Accordingly, for the above reasoning, Applicants respectfully submit that the present invention as recited in independent Claim 1 is not rendered

unpatentable within the meaning of 35 U.S.C. § 103(a) by the Jia, Gharachorloo, Luken, and Schulmeiss references alone or in combination.

With respect to independent Claim 9, Claim 9 includes limitation from Claim 1. Claim 9 also includes further limitations describing the manner in which the Bezier curve is evaluated. Applicants respectfully assert that the embodiment of the present invention recited in Claim 9 is different from the method and system for spline interpolation and their use in CNC of Jia, the parametric surface evaluation method and apparatus for a computer graphics display system of Luken, and the method and apparatus of Sherman.

As in the discussion of Claim 1 above, Claim 9 includes limitations describing a method for rendering curves or surfaces using the graphics rendering pipeline. Additionally, Claim 9 includes limitations describing the manner in which the Bezier curve is evaluated. Claim 9 recites limitations describing implementing a de Casteljau process in the graphics pipeline, evaluating a Bezier curve or surface using the de Casteljau process, implementing the de Casteljau process using a tri-linear interpolator included in the graphics pipeline, and rendering the Bezier curve or surface. Applicants respectfully submit that the combination of the cited references do not show or suggest the limitations of amended Claim 9.

Applicants respectfully assert that the use of the tri-linear interpolators to implement the de Casteljau process as recited in Claim 9 is not inherently taught by Luken. Applicants have reviewed the cited sections of Luken

(Luken col. 4, lines 40-54, col.15, lines 32-45 and do not understand them to inherently suggest or teach evaluating a Bezier curve or surface using the de Casteljau process and implementing the de Casteljau process using a tri-linear interpolator included in the graphics pipeline as recited in Claim 9. As such, Applicants respectfully assert that the present invention as recited in Claim 9 is not rendered obvious by the cited combination.

With respect to independent Claim 13, the above referenced Office Action states that independent Claim 13 is rendered unpatentable over Jia in view of Gharachorloo, Luken, and Schulmeiss. Applicants respectfully assert that the present invention as recited in Claim 13 is not rendered obvious by the combination of the cited references.

Specifically, Claim 13 includes limitations from Claim 1, additionally, Claim 13 recites additional limitations describing the method in which the NURBS surface is converted to a Bezier surface for evaluation and rendering using the tri-linear interpolators of the graphics rendering pipeline. For the reasons described above in the discussion of Claim 1, Applicants respectfully assert that these limitations are not shown or suggested by the cited combination. Hence, Applicants respectfully assert that the present invention as recited in Claim 13 is not rendered obvious by the cited combination.

With respect to independent Claim 20, the above referenced Office Action states that Claim 20 is rejected under 35 U.S.C. § 103(a) as being rendered unpatentable over Luken in view of Gharachorloo. Specifically, Claim

20 includes limitations of Claim 1, additionally, independent Claim 20 recites limitations describing the evaluation of the plurality of NURBS control points using tri-linear interpolation in the graphics rendering pipeline to obtain a plurality of points on a curve or surface defined by the NURBS model. For the reasons described above in the discussion of Claim 1, Applicants respectfully assert that these limitations are not shown or suggested by the cited combination. Applicants respectfully assert that the present invention as recited in Claim 20 is not rendered obvious by the cited references within the meaning of 35 U.S.C. § 103(a).

With respect to the dependent claims, each dependent claim includes the limitations of its respective base claim. Accordingly, for the reasons discussed above, Applicants respectfully assert that the present invention as recited in the dependent claims is not rendered obvious within the meaning of 35 U.S.C. § 103(a).

CONCLUSION

In summary, for the reasons discussed above, Applicants respectfully submit that the Claims as amended are now in condition for allowance, and such action is earnestly solicited by Applicants.

The Examiner is urged to contact Applicants' undersigned representative if the Examiner believes such action would expedite resolution of the present Application.

Please charge any additional fees or apply any credits to our PTO deposit account number: 23-0085.

Respectfully submitted,

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